

Sagittales Profil und Anschlußinstabilität

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WIK

Wirbelsäulenzentrum
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Kettenbruecke

Operationsplanung

Kann eine Anschlußinstabilität verhindert werden ?

Faktoren die zu beachten sind

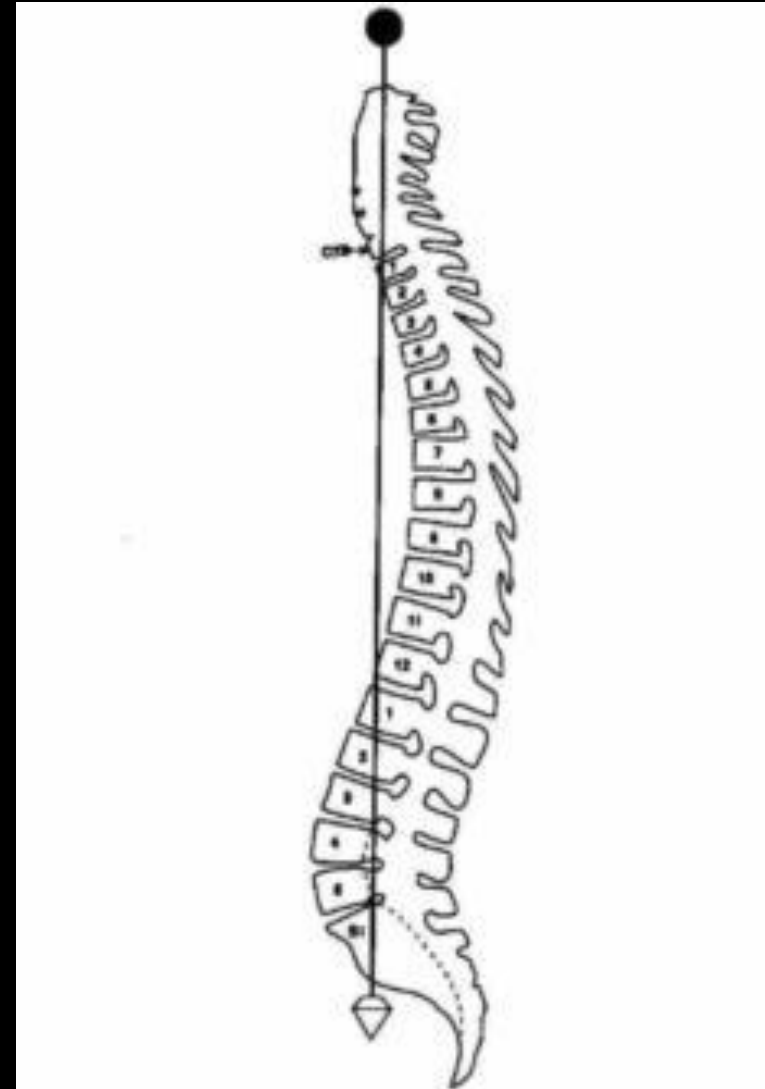
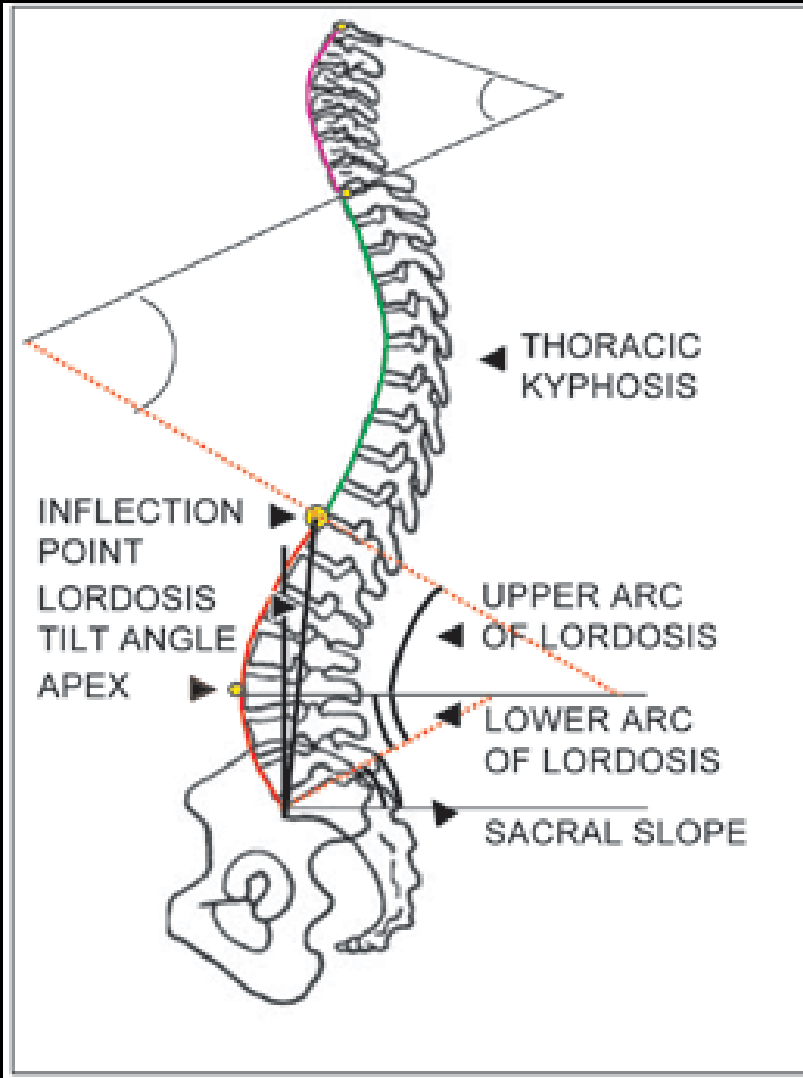
Alter des Patienten

Länge der Instrumentierung

Art der Implantate

Veränderungen im benachbarten Segment

Profil der WS, Becken



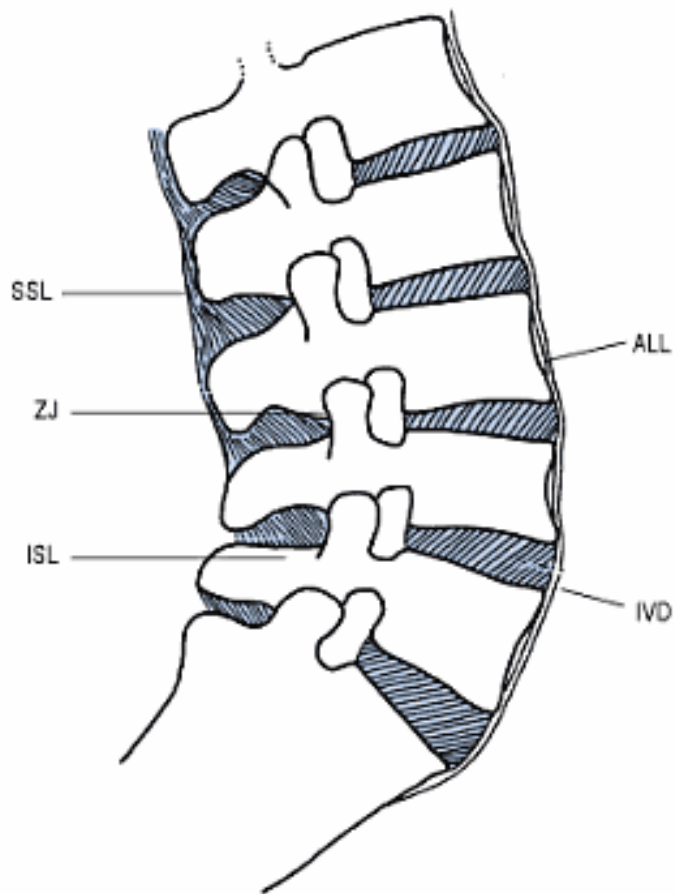


Figure 5.1 Lateral view of the intact, upright lumbar spine, showing its curved shape. ALL, anterior longitudinal ligament; IVD, intervertebral disc; ISL, interspinous ligament; SSL, supraspinous ligament; ZJ, zygapophysial joint.

the lumbosacral zygapophysial joints. A ligamentum flavum is present between the laminae of L5 and the sacrum, and an interspinous ligament connects the L5 and S1 spinous processes. However, there is no

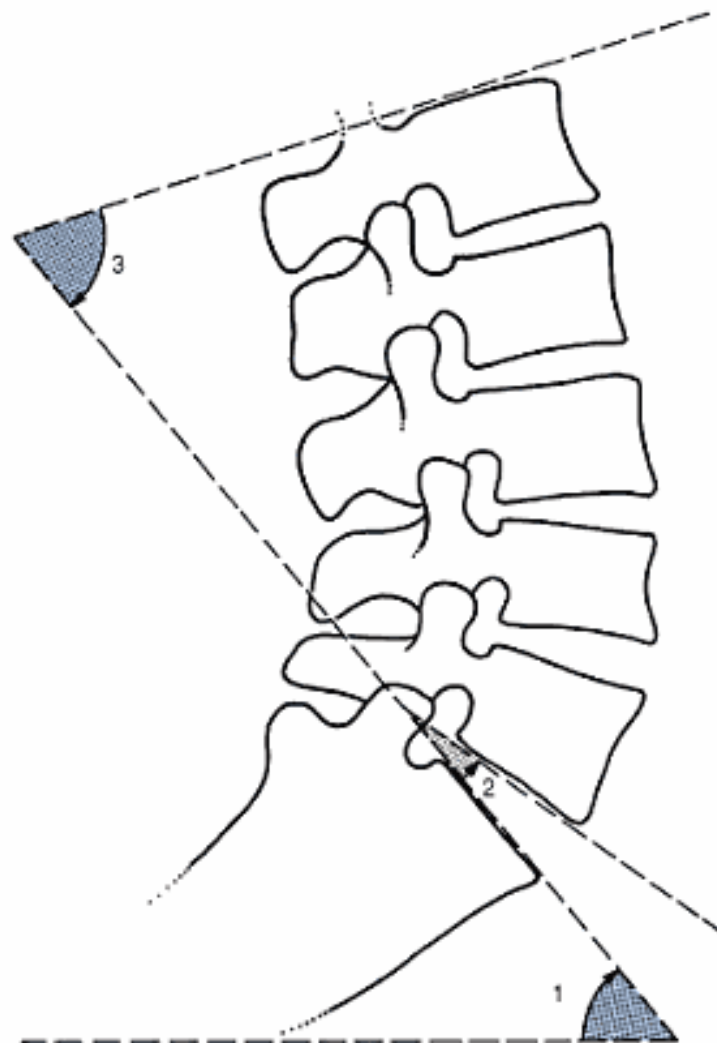
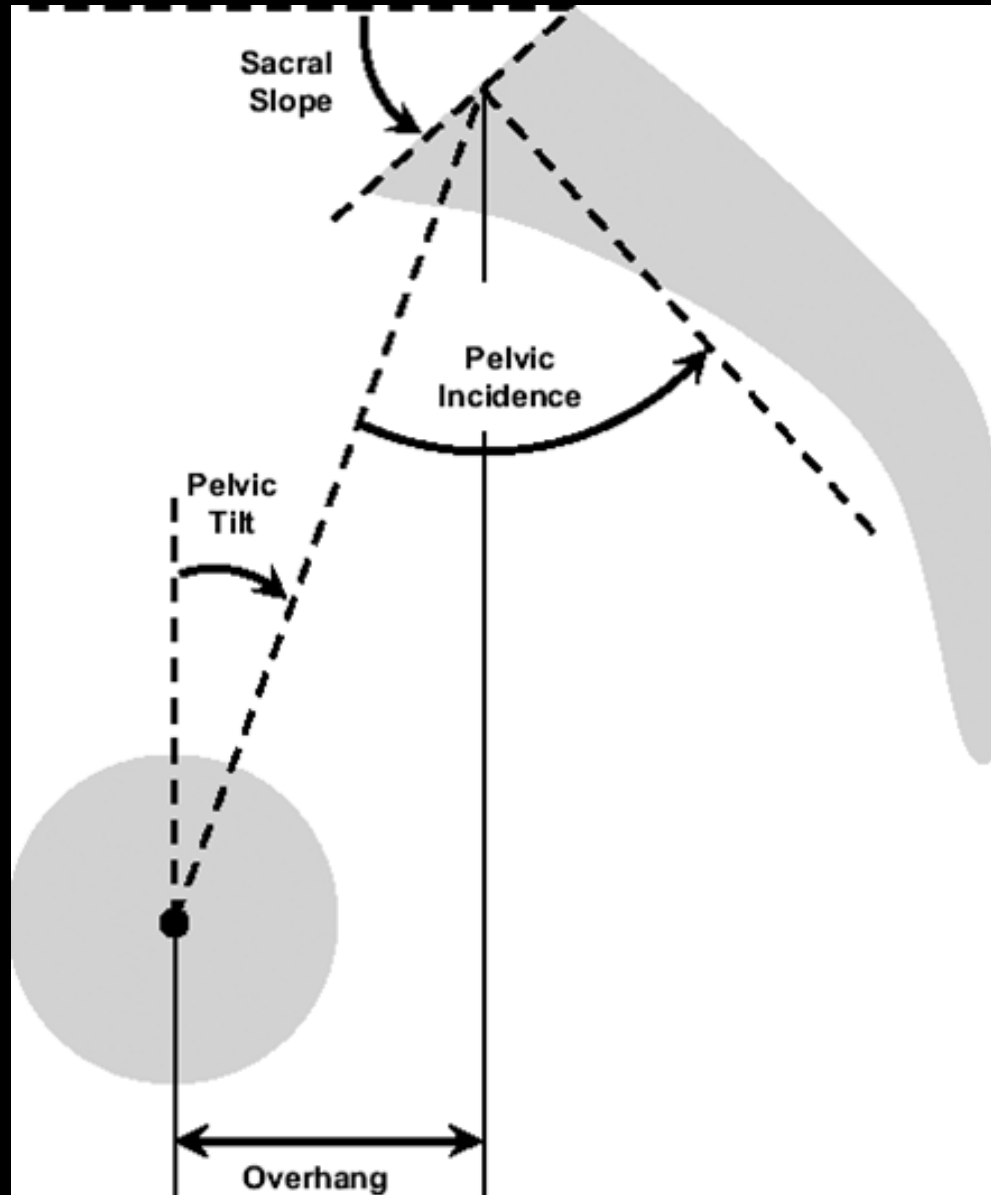




Figure 5.2 Some of the angles used to describe the lumbar spine. 1, angle formed by the top of the sacrum and the horizontal plane (mean value about 50°); 2, angle between the bottom of L5 and the top of the sacrum (mean value 16°); 3, angle between the top of L1 and the sacrum, used to measure the lumbar lordosis (mean value: about 70°).





Correlation between sagittal plane changes and adjacent segment degeneration following lumbar spine fusion

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Zusammenfassung

Adjacent segment degeneration following lumbar spine fusion remains a widely acknowledged problem, but there is insufficient knowledge regarding the factors that contribute to its occurrence. The aim of this study is to analyse the relationship between abnormal sagittal plane configuration of the lumbar spine and the development of adjacent segment degeneration. Eighty-three consecutive patients who underwent lumbar fusion for degenerative disc disease were reviewed retrospectively. Patients with spondylolytic spondylolisthesis and degenerative scoliosis were not included in this study. Mean follow-up period was 5 years. Results were analysed to determine the association between abnormal sagittal configuration and post operative adjacent segment degeneration. Thirty-one out of 83 patients (36.1%) showed radiographic evidence of adjacent segment degeneration.

Patients with normal C7 plumb line and normal sacral inclination in the immediate post operative radiographs had the lowest incidence of adjacent level change compared with patients who had abnormality in one or both of these parameters. The difference was statistically significant ($P < 0.02$).

There was no statistically significant difference in the incidence of adjacent level degeneration between male and female patients; between posterior fusion alone and combined posterolateral and posterior interbody fusions; and between fusions extending down to the sacrum and fusions stopping short of the sacrum. It was concluded that normality of sacral inclination is an important parameter for minimizing the incidence of adjacent level degeneration. Retrolisthesis was the most common type of adjacent segment change. Patients with post operative sagittal plane abnormalities should preferably be followed-up for at least 5 years to detect adjacent level changes.

Spine

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Spine:

1 February 2005 - Volume 30 - Issue 3 - pp 346-353

Diagnostics

Classification of the Normal Variation in the Sagittal Alignment of the Human Lumbar Spine and Pelvis in the Standing Position

Roussouly, Pierre MD; Gollogly, Sohrab MD; Berthonnaud, Eric PhD; Dimnet, Johannes PhD

Abstract

Study Design. A prospective radiographic study of 160 volunteers without symptoms of spinal disease was conducted.

Objectives. The objective of this study was to describe, quantify, and classify common variations in the sagittal alignment of the spine, sacrum, and pelvis.

Summary of Background Data. Previous publications have documented the high degree of variability in the sagittal alignment of the spine. Other studies have suggested that specific changes in alignment and the characteristics of the lumbar lordosis are responsible for degenerative changes and symptomatic back pain.

Methods. In the course of this study, anteroposterior and lateral radiographs of 160 volunteers in a standardized standing position were taken. A custom computer application was used to analyze the alignment of the spine and pelvis on the lateral radiographs. A four-part classification scheme of sagittal morphology was used to classify each patient.

Results. Reciprocal relationships between the orientation of the sacrum, the sacral slope, the pelvic incidence, and the characteristics of the lumbar lordosis were evident. The global lordotic curvature, lordosis tilt angle, position of the apex, and number of lordotic vertebrae were determined by the angle of the superior endplate of S1 with respect to the horizontal axis.

Conclusions. Understanding the patterns of variation in sagittal alignment may help to discover the association between spinal balance and the development of degenerative changes in the spine.





Pelvic incidence: a fundamental pelvic parameter for three-dimensional regulation of spinal sagittal curves

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Seiten	99-103
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SpringerLink Date	Dienstag, 5. Mai 1998

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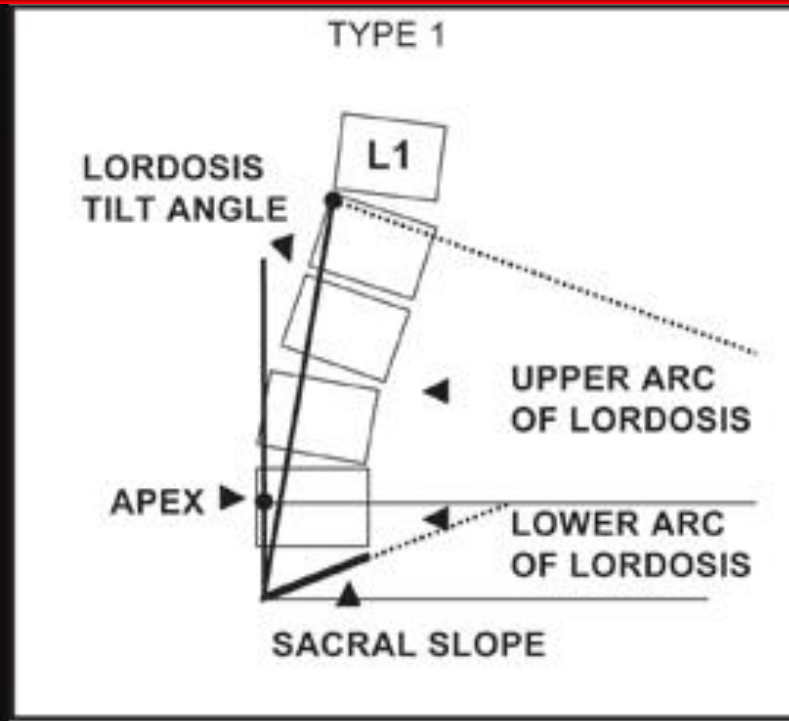
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Abstract This paper proposes an anatomical parameter, the pelvic incidence, as the key factor for managing the spinal balance. Pelvic and spinal sagittal parameters were investigated for normal and scoliotic adult subjects. The relation between pelvic orientation, and spinal sagittal balance was examined by statistical analysis. A close relationship was observed, for both normal and scoliotic subjects, between the anatomical parameter of pelvic incidence and the sacral slope, which strongly determines lumbar lordosis. Taking into account the Cobb angle and the apical vertebral rotation confers a three-dimensional aspect to this chain of relations between pelvis and spine. A predictive equation of lordosis is postulated. The pelvic incidence appears to be the main axis of the sagittal balance of the spine. It

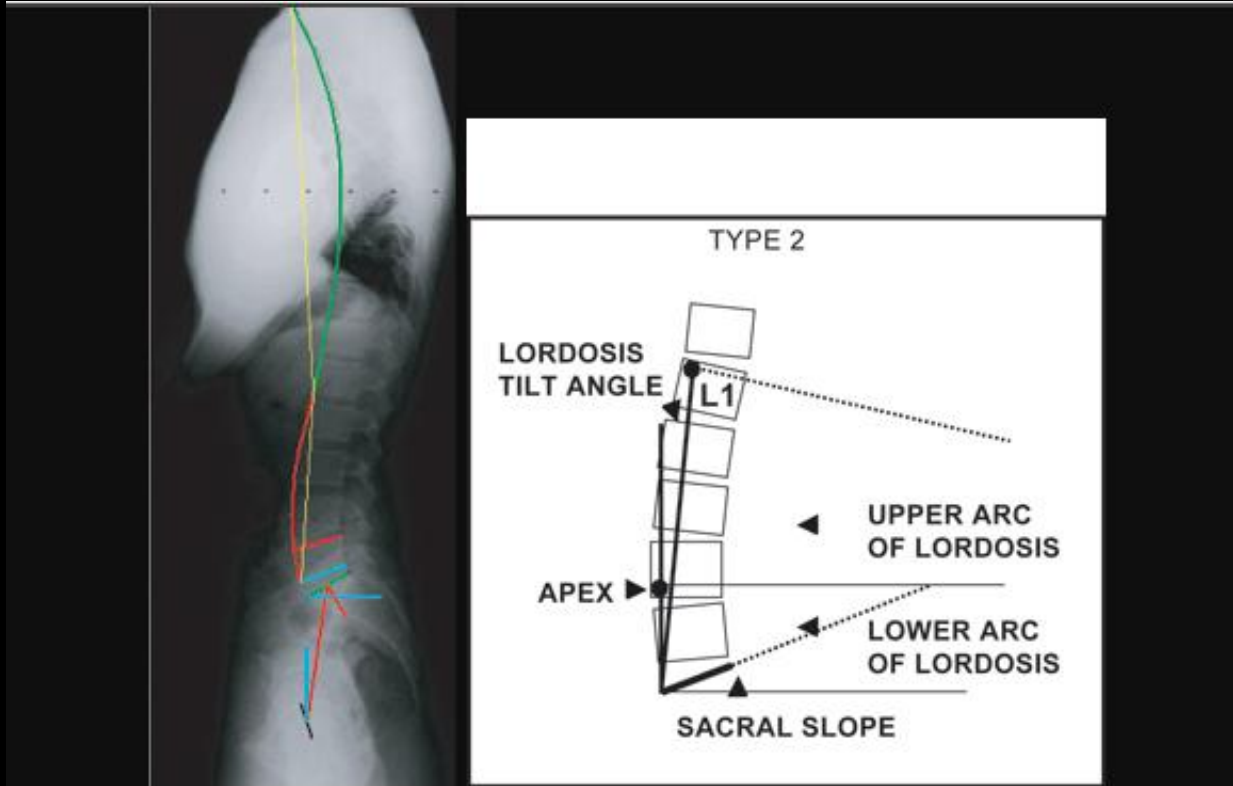
Type 1 Lordosis



The sacral slope is less than 35 degrees, which is usually associated with a low pelvic incidence (Figure 3A and B). The apex of the lumbar lordosis is located in the center of L5 vertebral body. The lower arc of lordosis is minimal, decreasing towards zero as the sacral slope approaches the horizontal. The inflection point is low and posterior, creating a short lordosis with a negative lordosis tilt angle. The upper spine has a significant kyphosis of the thoracolumbar junction and thorax.



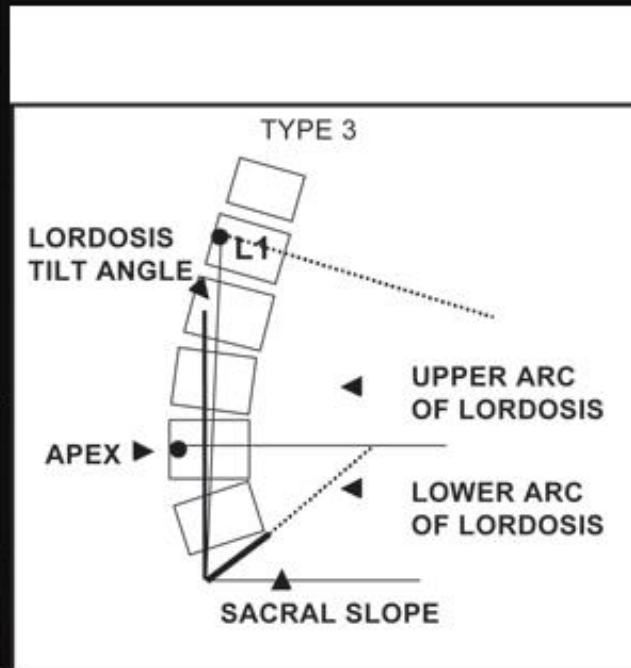
Type 2 Lordosis



The sacral slope is less than 35 degrees (Figure 4A and B). The apex of the lumbar lordosis is located at

The sacral slope is less than 35 degrees (Figure 4A and B). The apex of the lumbar lordosis is located at base of the L4 vertebral body. The lower arc of lordosis is relatively flat. The inflection point is higher and more anterior, decreasing the lordosis tilt angle, but increasing the number of vertebral bodies included in the lordosis. The entire spine is relatively hypolordotic and hypokyphotic.

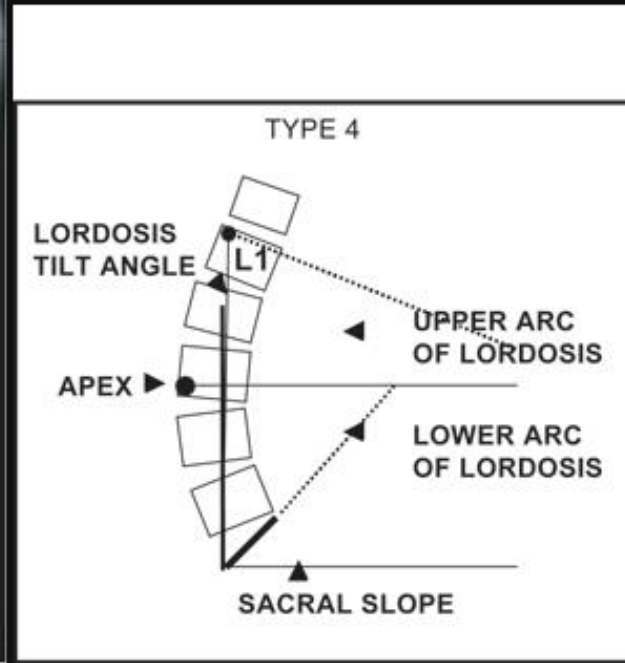
Type 3 Lordosis



The apex of the lumbar curve is between L4 and L5. The apex of the lumbar curve is in the center of the L4 vertebral body.

The sacral slope is between 35 and 45 degrees (Figure 5A and B). The apex of lumbar lordosis is in the center of the L4 vertebral body. The lower arc of lordosis becomes more prominent. The inflection point is at the thoracolumbar junction, and the lordosis tilt angle is nearly zero. An average of four vertebral bodies constitute the arc of lordosis. The spine is well-balanced.

Type 4 Lordosis



The sacral slope is greater than 45 degrees, which is associated with a high pelvic incidence (Figure 6A and B). The apex of the lumbar lordosis is located at the base of the L3 vertebral body or higher. The lower arc of lordosis is prominent, and the lordosis tilt angle is zero or positive. The number of vertebrae in a lordotic orientation is greater than five, and a state of segmental hyperextension exists.

In this cohort of normal volunteers, the sagittal alignment of the spine varied significantly. The average value for the global kyphosis of the thoracic curvature was 46.4 degrees with a range of 22.5 to 70.3 degrees. The inflection point where the spine transitioned from kyphosis to lordosis was located, on average, in the center of the L1 vertebral body, near the thoracolumbar junction (Table 1). However, this transition was noted to occur as proximally as the T10 vertebral body, and as distally as the L4 vertebral body. The average value for global lordosis of the lumbar curvature was 61.4 degrees with a range from 41.2 to 81.9 degrees. The apex of lumbar lordosis was located, on average, in the center of the L4 vertebral body, with a range from the center of L2 proximally to the base of L5 distally. The angle of the superior endplate of S1 with respect to the horizontal axis averaged 39.9 degrees, with a range from 21.2 to 65.9 degrees. Pelvic incidence averaged 51.9 degrees, with a range of 33.8 to 83.7 degrees. Pelvic tilt, defined as the included angle between a line drawn from the center of the hip axis to the center of the superior end plate of S1 and the vertical axis, averaged 12.0 degrees, with a range from -5.1 to 30.6 degrees.

The correlation between the sacral slope and global lordosis ($R = 0.86$) indicates that the total amount of lordosis is determined by the relationship of the superior endplate of S1 with respect to the horizontal axis. Global lordosis increases as the sacral slope becomes more vertical, demonstrating a reciprocal relationship between the orientation of the sacrum and the characteristics of the lumbar lordosis. There is also a strong correlation between sacral slope and pelvic incidence ($R = 0.80$). *Statistically significant correlations between pelvic incidence and global lordosis ($R = 0.64$), sacral slope and position of the apex ($R = 0.52$), sacral slope and lordosis tilt angle ($R = 0.53$), and position of the apex and lordosis tilt angle ($R = 0.72$) also exist.*

The correlations between the various parameters of lumbar and pelvic alignment indicate that characteristics of the lumbar lordosis are most dependent upon the orientation of the sacral slope and the pelvis. The upper arc of lumbar lordosis remains relatively constant, with an average value of approximately 20 degrees in all proposed types of sagittal alignment. In contrast, the lower arc of lordosis is the most important determinant of the global lordosis; lordosis tilt angle, position of the apex, and number of lordotic vertebrae. **A sacral slope less than 35° and a low pelvic incidence are associated with a relatively flat, short lumbar lordosis. A sacral slope greater than 45° and a high pelvic incidence are associated with long, curved lumbar lordosis.** This reciprocal relationship between the orientation of the sacrum and the characteristics of the lumbar lordosis is an important component of overall sagittal alignment.

Many authors have commented upon the negative consequences of “flat back syndrome”, and the importance of preserving lumbar lordosis during arthrodesis of the lumbar spine. In a review of the eighty-three consecutive lumbar spine fusions, an anterior shift in the C7 plumb line and a vertically oriented sacrum was found to be a statistically significant predictor of surgical treatment for adjacent segment degeneration within five years

Cervical fusion

Instr Course Lect. 2009;58:747-56.

Adjacent segment disease after cervical spine fusion.

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Anterior cervical discectomy and fusion is one of the most common cervical spine procedures. Although it is usually successful in relieving the symptoms of radiculopathy and myelopathy, the subsequent development of clinically significant disk disease at levels adjacent to the fusion is a matter of concern. Adjacent segment cervical disease occurs in approximately 3% of patients; the incidence is expected to increase to more than 25% of patients within the first 10 years after the index fusion procedure. The disease is well described in the literature, and significant basic science and clinical research has been conducted. Nonetheless, the cause of the disease is a matter of debate. A combination of factors probably contributes to its development, including the increased biomechanical stress placed on the disk space adjacent to a fusion and the natural

[Clinical observation to adjacent-segment disease after anterior cervical discectomy and fusion]

[Article in Chinese]

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OBJECTIVE: To probe the etiopathogenesis of adjacent-segment disease by analyzing the imageology data and clinical neurological function in patients with anterior cervical discectomy and fusion (ACDF) harvested by long-term follow-up. **METHODS:** A retrospective study was performed on 52 patients who had undergone ACDF with perfect documents from January 1990 to April 2003. Of the patients, 45 were males and 7 were females with a mean age of 48.5 years (range from 25 to 72 years). There was the fusion of 10 one-levels, 38 two-levels and 4 three-levels. The cervical anterior-posterior and lateral X-ray, CT and MRI examination were performed before the operation. Clinical neurological function was recorded by the Nurick score, and this score at 6 weeks after the operation was compared with the later follow-up. In the radiological examination, the motion of adjacent vertebrae and osteophyte formation were reviewed on X-ray and CT, and were converted to the semi-quantitative degeneration score according to the Goffin method. The correlation between Nurick score or degeneration score and the age at operation or fusion levels was compared by Spearman correlation coefficients. The cervical canal sizes of adjacent level and remote level on MRI were reviewed and compared with each other by t test. **RESULTS:** The follow-up period was 3 to 10 years, 6.9 years on average. There was difference in the Nurick score between the 6th week after operation (1.07 +/- 0.84) and the later follow up (1.92 +/- 1.28) by rank test ($P < 0.05$). There was no correlation between the Nurick score change and the age at operation ($r = 0.21, P > 0.05$) or fused levels ($r = 0.30, P > 0.05$) by Spearman correlation coefficients. There was obvious difference in degeneration score between the 6th week after operation (0.73 +/- 0.67) and the later follow up (1.58 +/- 1.06), ($P < 0.01$). There was no correlation between the degeneration score change and the age at operation ($r = 0.35, P > 0.05$) or fusion levels ($r = 0.38, P > 0.05$) by Spearman correlation coefficients. The cervical canal size reductions were (1.7 +/- 1.1) mm at superior adjacent level, (1.2 +/- 0.6) mm at inferior adjacent level and (0.30 +/- 0.68) mm at remote level. There was obvious difference between superior or inferior and remote level by t test ($P < 0.01$). The adjacent level developed prominent degeneration together with nerve function change after the fusion operation and displayed correlation between degeneration and nerve function change ($r = 0.41, P < 0.05$). **CONCLUSION:** The adjacent-segment disease after interbody fusion is produced by multiple factors. The natural progression in adjacent disc, biomechanical natural change resulting from interbody fusion, destruction to ligament structure in front of cervical vertebrae by operation, and bone graft model are important factors not to be ignored.

Asymptomatic DD

Adjacent segment disease after anterior cervical interbody fusion.

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BACKGROUND CONTEXT: There have been many follow-up studies on anterior interbody fusion for cervical nerve root and spinal cord compression, and excellent neurological outcomes have been reported. However, postoperative degenerative changes at adjacent discs may lead to the development of new radiculopathy or myelopathy. In the previous reports, the incidence of symptomatic adjacent segment disease has ranged from 7% to 15%. **PURPOSE:** The present study was undertaken to investigate the incidence of symptomatic adjacent segment disease after anterior cervical interbody fusion (ACIF) and to identify the factors that are related to the development of this disease. **STUDY DESIGN/SETTING:** This is a retrospective cohort study. **PATIENT SAMPLE:** A total of 112 patients were followed up clinically and radiologically for more than 2 years. **OUTCOME MEASURES:** Follow-up evaluation was primarily by means of clinical visits. The postoperative course of any symptoms, the findings of neurological examination and serial follow-up radiographs were performed in all patients. **METHODS:** The diagnosis of symptomatic adjacent segment disease was based on the presence of new radiculopathy or myelopathy symptoms referable to an adjacent level, and the presence of a compressive lesion at an adjacent level by magnetic resonance imaging or myelography. We evaluated the correlation between the incidence of symptomatic adjacent segment disease and the following clinical parameters (age at operation, sex, number of the levels fused) and radiological parameters (preoperative cervical spine alignment, preoperative range of motion of C2-C7 cervical spine, anteroposterior spinal canal diameter, preoperative existence of an adjacent segment degeneration on plain radiograph, myelography and magnetic resonance imaging [MRI]). **RESULTS:** Symptomatic adjacent segment disease developed in 19 of 112 patients (19%) followed. A Kaplan-Meier survival analysis was performed in order to follow the disease-free survival of the entire series of patients. The disease-free survival rates were 89% at 5 years, 84% at 10 years and 67% at 17 years. The incidences of indentation of dura matter on preoperative myelography or disc protrusion on MRI at the adjacent level were significantly higher in disease cases ($p=.0087$, $.0299$, respectively; chi-squared test). However, the other parameters did not show a statistically significant difference. There were seven cases (37%) who had failure of nonoperative treatment and additional operations were performed. **CONCLUSIONS:** The incidence of symptomatic adjacent segment disease after ACIF was higher when preoperative myelography or MRI revealed asymptomatic disc degeneration at that level regardless of the number of the levels fused, preoperative alignment, spinal canal diameter or fusion alignment.

PMID: 15541693 [PubMed - indexed for MEDLINE]

Pedikelsystem

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[Spine \(Phila Pa 1976\)](#). 2004 Sep 1;29(17):1938-44.

Adjacent segment disease after lumbar or lumbosacral fusion: review of the literature.

[Park P](#), [Garton HJ](#), [Gala VC](#), [Hoff JT](#), [McGillicuddy JE](#).

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STUDY DESIGN: Review of the literature. **OBJECTIVES:** Review the definition, etiology, incidence, and risk factors associated with as well as potential treatment options. **SUMMARY OF BACKGROUND DATA:** The development of pathology at the mobile segment next to a lumbar or lumbosacral spinal fusion has been termed adjacent segment disease. Initially reported to occur rarely, it is now considered a potential late complication of spinal fusion that can necessitate further surgical intervention and adversely affect outcomes. **METHODS:** MEDLINE literature search. **RESULTS:** The most common abnormal finding at the adjacent segment is disc degeneration. Biomechanical changes consisting of increased intradiscal pressure, increased facet loading, and increased mobility occur after fusion and have been implicated in causing adjacent segment disease. Progressive spinal degeneration with age is also thought to be a major contributor. From a radiographic standpoint, reported incidence during average postoperative follow-up observation ranging from 36 to 369 months varies substantially from 5.2 to 100%. Incidence of symptomatic adjacent segment disease is lower, however, ranging from 5.2 to 18.5% during 44.8 to 164 months of follow-up observation. The rate of symptomatic adjacent segment disease is higher in patients with transpedicular instrumentation (12.2-18.5%) compared with patients fused with other forms of instrumentation or with no instrumentation (5.2-5.6%). Potential risk factors include instrumentation, fusion length, sagittal malalignment, facet injury, age, and pre-existing degenerative changes. **CONCLUSION:** Biomechanical alterations likely play a primary role in causing adjacent segment disease. Radiographically apparent, asymptomatic adjacent segment disease is common but does not correlate with functional outcomes. Potentially modifiable risk factors for the development of adjacent segment disease include fusion without instrumentation, protecting the facet joint of the adjacent segment during placement of pedicle screws, fusion length, and sagittal balance. Surgical management, when indicated, consists of decompression of neural elements and extension of fusion. Outcomes after surgery, however, are modest.

PMID: 15534420 [PubMed - indexed for MEDLINE]

PLIF

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[J Spinal Disord Tech.](#) 2009 Oct;22(7):463-7.

Motion-preserving surgery can prevent early breakdown of adjacent segments: Comparison of posterior dynamic stabilization with spinal fusion.

[Kanayama M](#), [Togawa D](#), [Hashimoto T](#), [Shigenobu K](#), [Oha F](#).

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STUDY DESIGN: A retrospective study. **OBJECTIVES:** This study aims to determine the prevalence and nature of adjacent-segment deterioration after posterior ligamentoplasty, posterolateral lumbar fusion (PLF) versus posterior lumbar interbody fusion (PLIF). **SUMMARY OF BACKGROUND:** Motion-preserving technologies including disc arthroplasty and ligamentoplasty were gaining interest to reduce the risk of adjacent-segment morbidity. However, few clinical studies have reported the prevalence of adjacent-segment disease in motion-preserving surgeries. **METHODS:** Two-hundred and eighteen consecutive patients who had undergone single-level posterior L4-L5 pedicle-screw-instrumented fusion or ligamentoplasty were reviewed at minimum 2-year follow-up. They were 91 males and 127 females with mean age of 62 years. Follow-up period was averaged 41 months and follow-up rate was 97.3%. There were 78 cases of PLIF, 75 of PLF, and 65 of ligamentoplasty. Demographics were not statistically different among the 3 groups. Prevalence of adjacent-segment morbidity (radiculopathy associated with newly developed pathologies at neighboring levels) and required additional surgery were investigated. **RESULTS:** Prevalence of adjacent-segment morbidity was 14.1% in PLIF, 13.3% in PLF, and 9.2% in ligamentoplasty; the time to represent symptom was averaged 25.2, 39.3, and 51.8 postoperative months, respectively. Additional surgeries for adjacent-segment pathologies were required for 7.6% in PLIF, 6.7% in PLF, and 1.5% in ligamentoplasty. Although all PLF cases needed only decompression surgeries, 66.7% of reoperations in the PLIF group required fusion owing to progression of adjacent-segment instability. **CONCLUSIONS:** Prevalence of adjacent-segment disease and reoperation rate seemed to be lower in ligamentoplasty than fusion surgeries, but the difference was not significant. Ligamentoplasty circumvented adjacent-segment disease for longer period than fusion surgeries. Although the rates of additional surgeries in PLIF and PLF were comparable, PLIF developed adjacent-level instability and required fusion surgery more frequently than PLF.

PMID: 20075807 [PubMed - in process]

> 50a, bis L1, PLIF=PLF

Spine (Phila Pa 1976). 2007 Sep 15;32(20):2253-7.

Adjacent segment disease following lumbar/thoracolumbar fusion with pedicle screw instrumentation: a minimum 5-year follow-up.

Cheh G, Bridwell KH, Lenke LG, Buchowski JM, Daubs MD, Kim Y, Baldus C.

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STUDY DESIGN: Retrospective radiographic outcomes analysis. **OBJECTIVE:** We had 3 hypotheses: 1) a longer fusion; 2) a more proximal instrumented vertebra, and 3) circumferential fusion versus posterior-only fusion would increase the likelihood of adjacent segment disease (ASD). **SUMMARY OF BACKGROUND DATA:** The literature analyzing risk factors, prevalence, and presentation of patients with ASD is varied and without clear consensus. **METHODS:** A total of 188 patients with minimum 5-year follow-up who had lumbar/thoracolumbar fusion with pedicle screw instrumentation for degenerative disorders were included. Radiographic ASD was defined by: 1) development of spondylolisthesis >4 mm, 2) segmental kyphosis >10 degrees, 3) complete collapse of disc space, or 4) more than 2 grades worsening of Weiner classification. Clinical ASD was defined as 1) symptomatic spinal stenosis, 2) intractable back pain, or 3) subsequent sagittal or coronal imbalance. **RESULTS:** Radiographic ASD occurred in 42.6% (80 of 188) of patients. Patients with radiographic ASD had worse Oswestry scores (20.3 vs. 12.5; $P = 0.001$) at ultimate follow-up than those without ASD. Clinical ASD developed in 30.3% (57 of 188) of patients. Clinical ASD manifested as spinal stenosis ($n = 47$), instability-type back pain ($n = 5$), and sagittal or coronal imbalance ($n = 5$). Age at surgery over 50 years and length of fusion were significant risk factors for the development of ASD in the lumbar spine. Fusion to L1-L3 proximally increased the risk of ASD when compared with L4 and L5. Circumferential fusion versus posterior fusion was not a significant factor in the development of ASD. **CONCLUSION:** Patients over the age of 50 were at higher risk of developing clinical ASD than those 50 years old or younger. Length of fusion was a significant risk factor in the development of ASD in the lumbar spine. Fusion up to L1-L3 increased the risk of ASD when compared with L4 and L5. Circumferential fusion, as opposed to posterolateral fusion, was not a statistically significant risk factor for the development of ASD.

PMID: 17873819 [PubMed - indexed for MEDLINE]

PLF/PEDIKELSYSTEM: 46,8% -radiologisch

Fukuoka Igaku Zasshi. 2008 May;99(5):107-13.

Degenerative change in the adjacent segments to the fusion site after posterolateral lumbar fusion with pedicle screw instrumentation--a minimum 4-year follow-up.

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BACKGROUND: Controversy remains regarding the subsequent degeneration of adjacent segments, and little reliable information could be found in the literature regarding long-term clinical results and adjacent segment degeneration. The objective of this study is to investigate the degenerative change of adjacent segments to the fusion site and clinical outcome after posterolateral lumbar fusion with pedicle screw instrumentation and identify the risk factors in degenerative change at adjacent segments. **METHODS:** Thirty-two patients who underwent posterolateral lumbar fusion and were able to be followed over four years were evaluated in this study. The intervertebral disc height, percent of slip, lumbosacral joint angle, lumbar lordosis and disc angle were all examined. The postoperative progression of degeneration at adjacent segments were defined as more than a 50 % narrowing in the adjacent disc height or more than a 5 % slip in adjacent segments in comparison to the preoperative neutral lateral radiographs. The clinical results were assessed using an evaluation scores for lumbar lesions proposed by the Japanese Orthopedic Association. **RESULTS:** Fifteen (46.8%) of the 32 patients had adjacent segment degeneration including slip or narrowing. No significant correlation was found between the adjacent segment degeneration and the recovery rate at the final follow-up. In addition, no significant correlation was observed between the adjacent segment degeneration at the latest follow-up and postoperative radiographic measurements. **CONCLUSIONS:** The rate of radiographic degeneration at the adjacent segments was 46.8%. No significant correlation was found between degenerative change in the adjacent segments and the clinical results. We could not identify any preoperative radiographic factors which might have influenced the segments adjacent to the fusion.

PMID: 18788454 [PubMed - indexed for MEDLINE]

PF/GRAF

J Neurosurg. 2001 Jul;95(1 Suppl):5-10.

Adjacent-segment morbidity after Graf ligamentoplasty compared with posterolateral lumbar fusion.

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Comment in:

J Neurosurg. 2002 Jan;96(1 Suppl):139-40.

OBJECT: Of concern to spine surgeons are accelerated degenerative changes of motion segments located above and below where spinal fusion has been performed. Graf artificial ligament stabilization has been developed to avoid the adverse effect of spinal fusion. The object of this study was to assess the adjacent-segment morbidity of Graf ligamentoplasty compared with posterolateral fusion (PF) in which instrumentation was used. **METHODS:** Data obtained in 45 patients who underwent L4-5 Graf ligamentoplasty (18 patients) or PF with instrumentation (27 patients) were reviewed retrospectively. The minimum follow-up period was 5 years. In the PF group a solid fusion rate of 92.6% was achieved. Radiographic evaluation included assessment of lumbar sagittal alignment, range of motion (ROM), and adjacent-disc degeneration. Adjacent-segment morbidity was clinically assessed by determining the reoperation rate. Graf ligamentoplasty maintained regional lordosis and flexibility (13 degrees in L4-5 lordosis; 4.4 degrees in L4-5 ROM). Although there was no difference in preoperative adjacent-disc condition between the two groups, radiographic evidence of adjacent-disc deterioration was observed more frequently in patients in the PF group than the Graf group (25% and 6% at L1-2; 38% and 6% at L2-3; 38% and 18% at L3-4; and 43% and 18% at L5-sacrum, respectively). One case in the Graf group (5.6%) and five cases in the PF group (18.5%) required additional surgeries for adjacent-segment lesions. **CONCLUSIONS:** Graf ligamentoplasty cannot completely replace spinal fusion. In a well-selected group of patients, however, it was shown to maintain lumbar mobility and sagittal alignment, and it decreased the risk of adjacent-segment deterioration compared with PF with instrumentation.

PMID: 11453431 [PubMed - indexed for MEDLINE]

TDR

J Neurosurg Spine. 2009 Dec;11(6):715-23.

Effect of lumbar total disc arthroplasty on the segmental motion and intradiscal pressure at the adjacent level: an in vitro biomechanical study: presented at the 2008 Joint Spine Section Meeting Laboratory investigation.

Ingalhalikar AV, Reddy CG, Lim TH, Torner JC, Hitchon PW.

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OBJECT: The artificial disc has been proposed as an alternative to spinal fusion for degenerative disc disease. The primary aim of this biomechanical study was to compare motion and intradiscal pressure (IDP) in a ball-and-socket artificial disc-implanted cadaveric lumbar spine, at the operative and adjacent levels, using a displacement-controlled setup. A secondary comparison involved a "salvage" construct, consisting of pedicle screws (PSs) added in supplementation to the artificial disc construct.

METHODS: Ten human cadaveric lumbosacral spines (L2-S1) were potted at L-2 and S-1. All measurements were initially made in the intact spine, followed by implantation of the artificial disc, and finally by the salvage PS condition. For the artificial disc condition, a Maverick ball-and-socket artificial disc was implanted at L4-5. For the PS condition, CD Horizon PSs were placed at L4-5, and the artificial disc was left in place. A displacement-controlled, custom-designed testing apparatus was used to impart motion in the sagittal and coronal planes. Motion at both the implanted level (L4-5) and immediately adjacent levels (L3-4 and L5-S1) was measured. Intradiscal pressure at the rostral adjacent level (L3-4) was also measured. The Tukey test was used for statistical analysis ($p < 0.05$).

RESULTS: In flexion, no significant difference was noted between the artificial disc and the intact spine with regard to motion at the operative level, motion at adjacent levels, or IDP. In lateral bending, while the artificial disc significantly decreased operative-level motion ($p < 0.05$), no significant difference was noted in adjacent-level motion or IDP. With regard to extension, the artificial disc significantly increased operative level motion and decreased the rostral adjacent level (L3-4) motion and IDP ($p < 0.05$). Caudal adjacent-level (L5-S1) motion was not significantly different. In flexion and lateral bending, the addition of PSs significantly decreased motion at the implanted level when compared with the intact spine and the artificial disc ($p < 0.05$). This decrease in motion at the index level was associated with a compensatory increase in motion at both adjacent levels in flexion only ($p < 0.05$), but not in lateral bending ($p > 0.05$). The IDP was significantly increased in lateral bending but not in flexion. With regard to extension, the significant decrease in IDP that was noted with the artificial disc persisted despite the addition of PSs ($p < 0.05$).

CONCLUSIONS: The artificial disc either maintains or reduces adjacent-level motion and pressure, compared with the intact spine. The addition of PSs to the artificial disc construct leads to significantly increased motion at adjacent levels in flexion and significantly increased IDP in lateral bending. At the operative level, the artificial disc is associated with hypermobility in extension, which is restored to the intact state after the addition of supplementary PSs.

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Anschlußinstabilität + Stenose

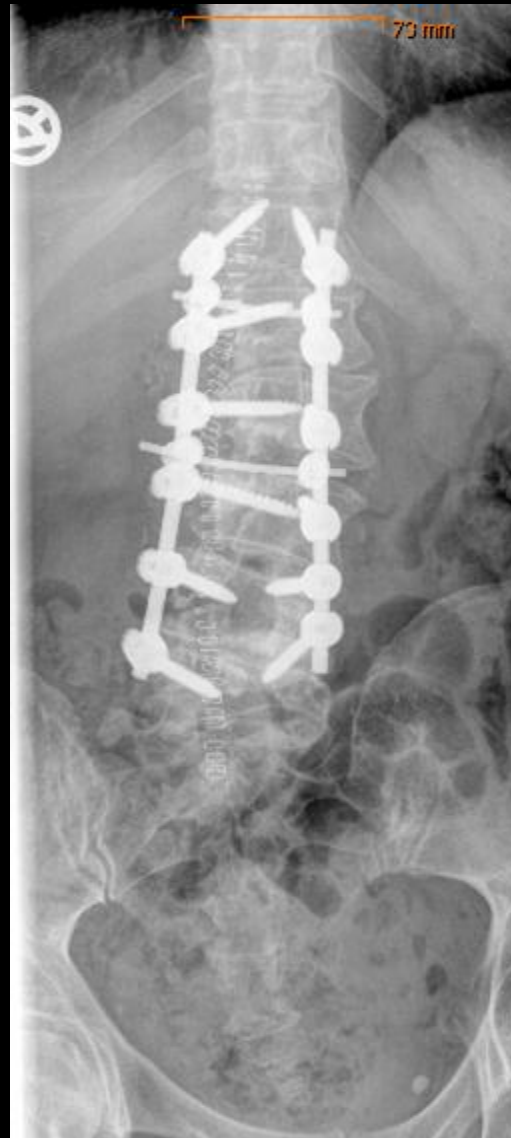




Zn mehrfachen Dekompressionen 2005

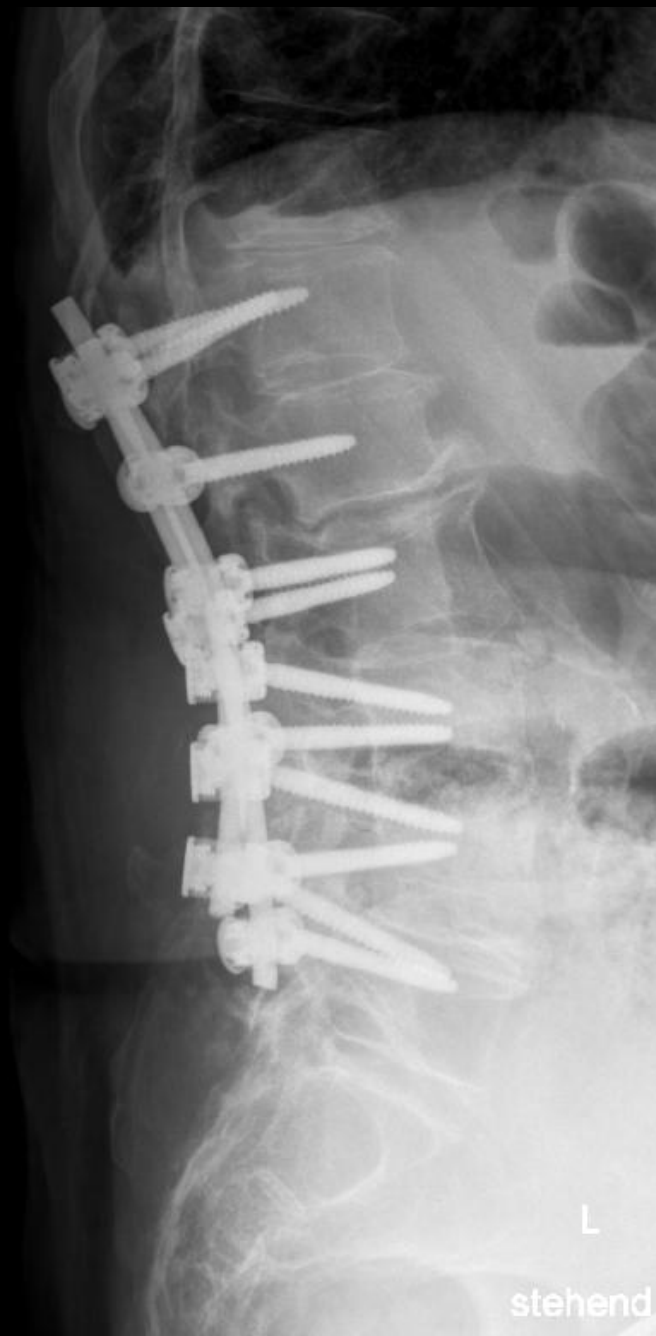


Procedere ?

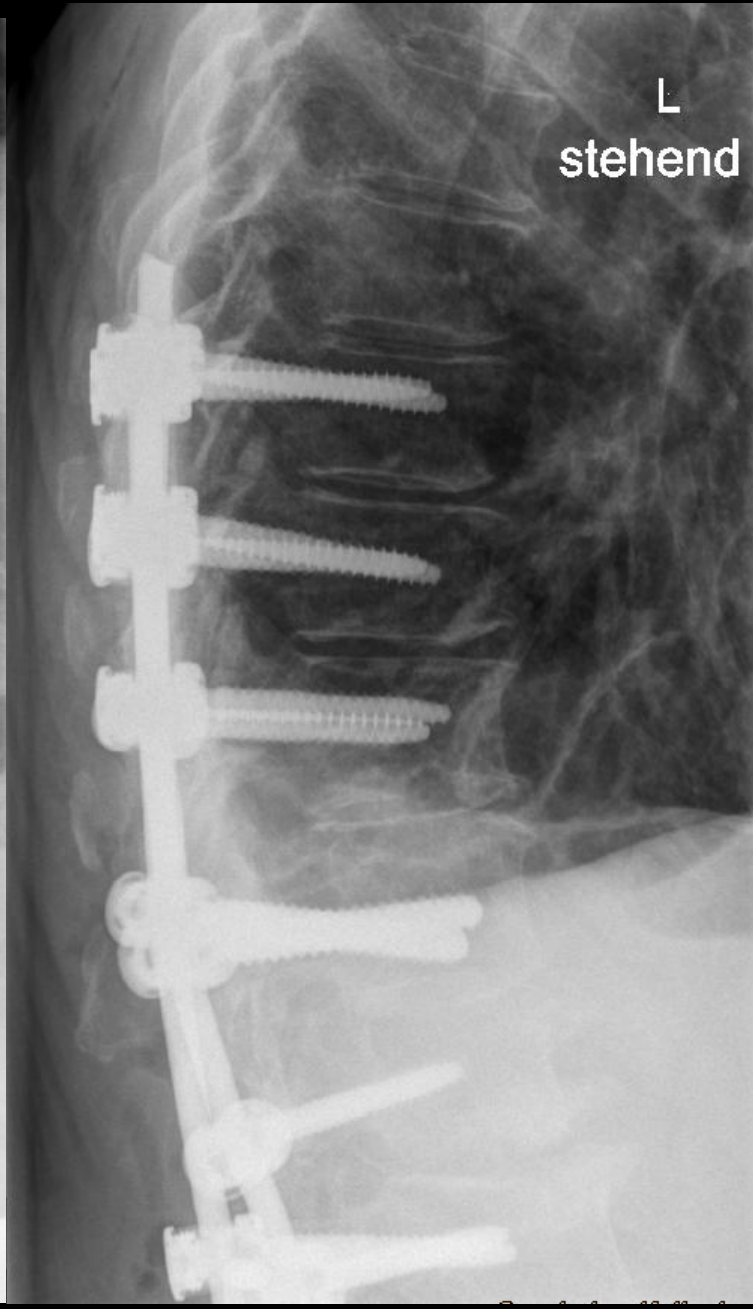
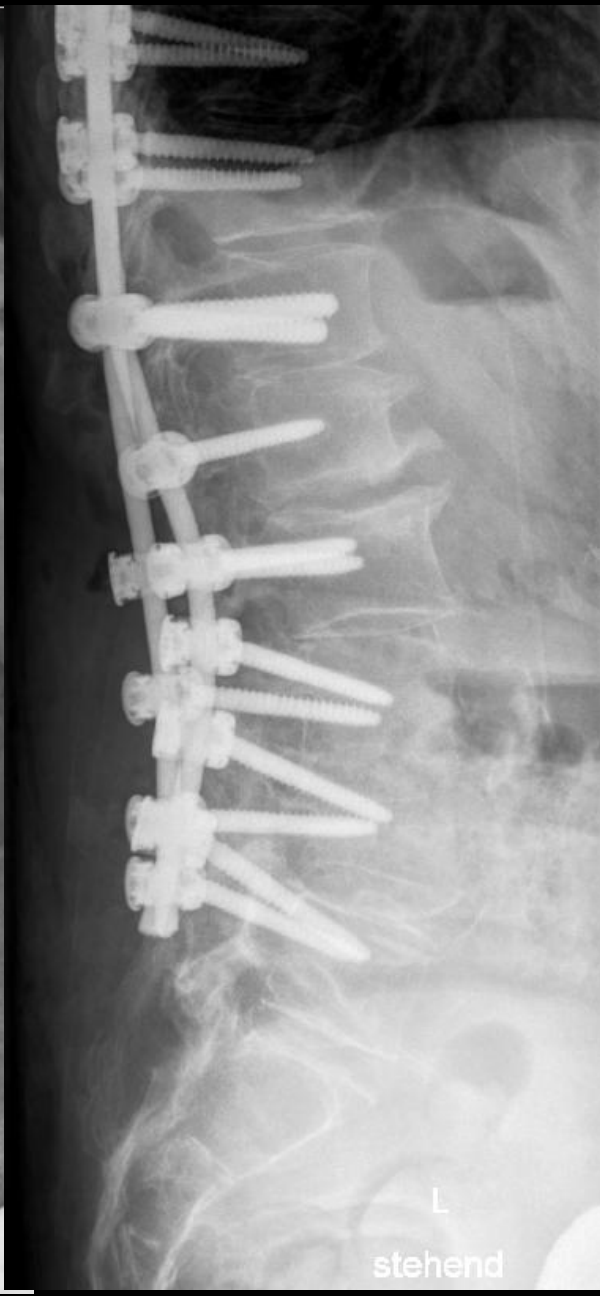




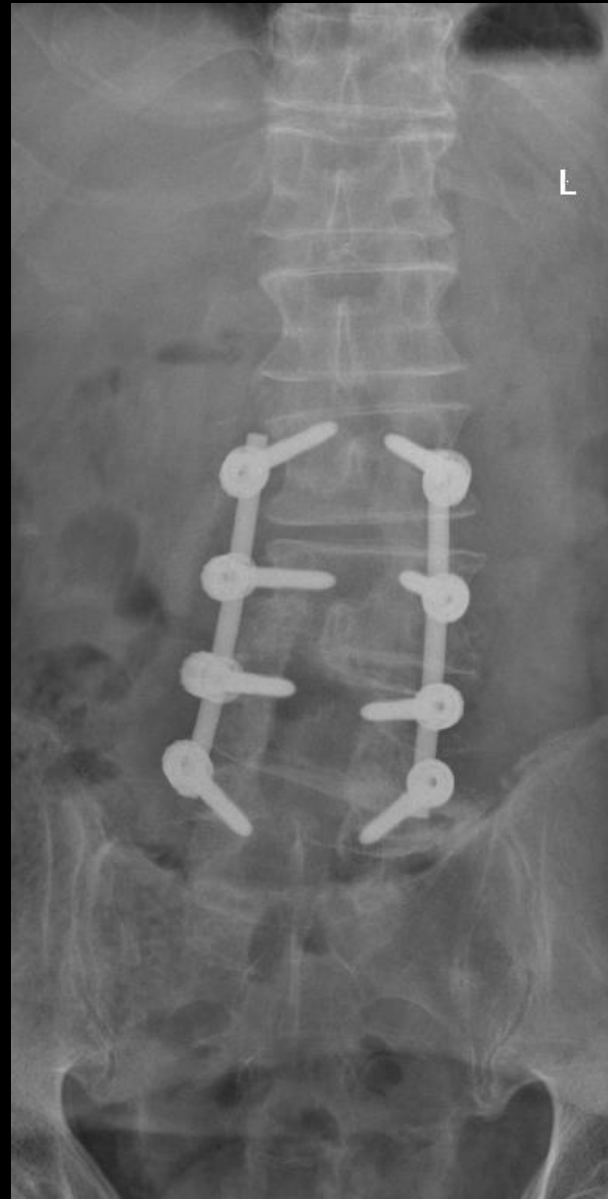
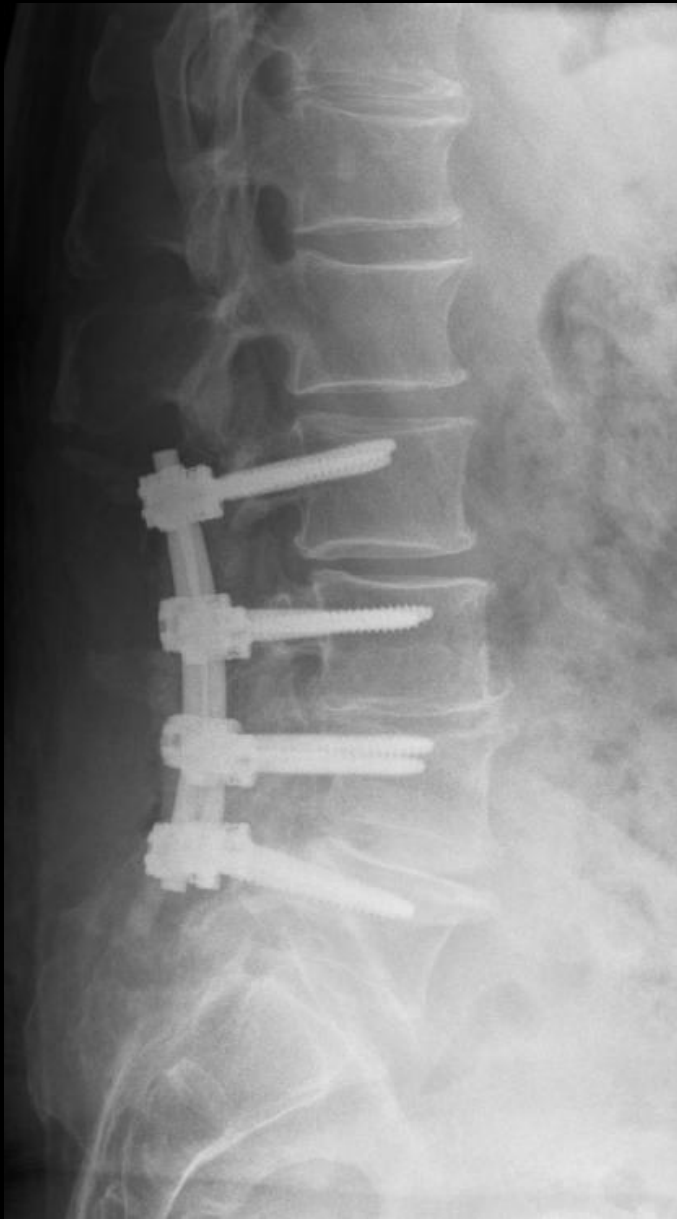


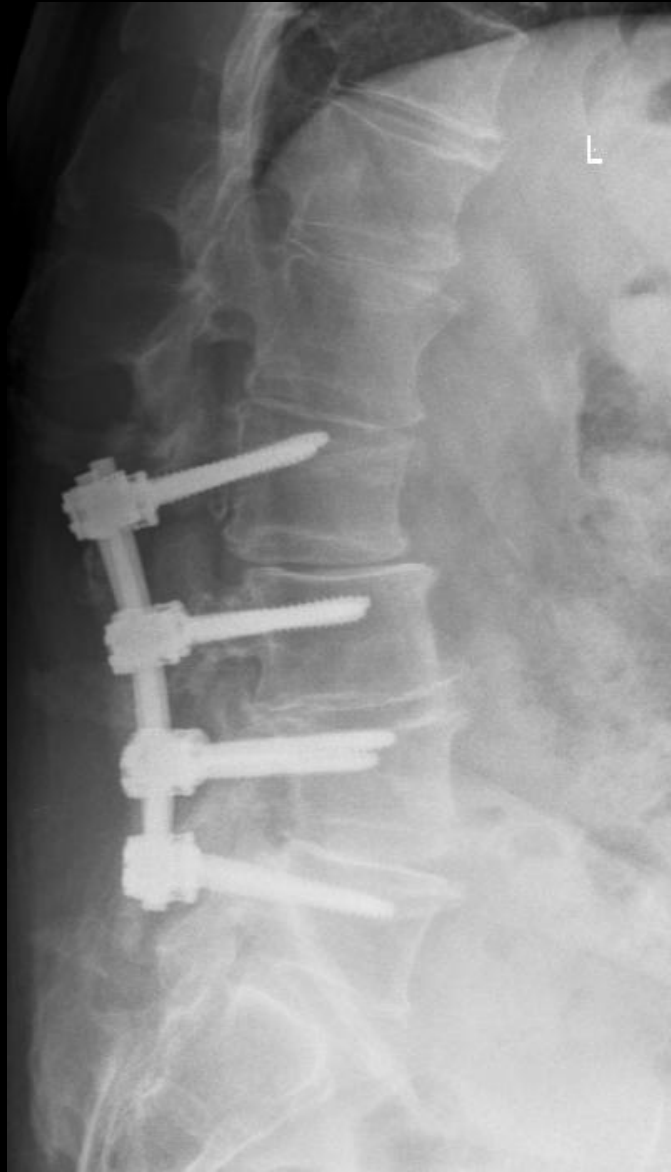


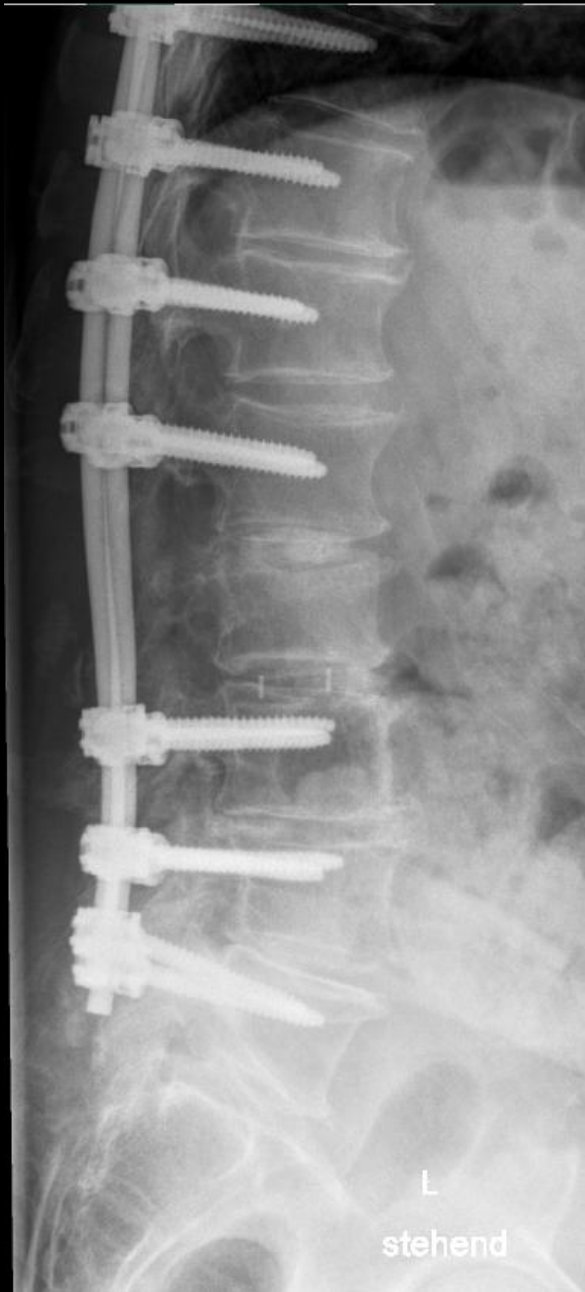
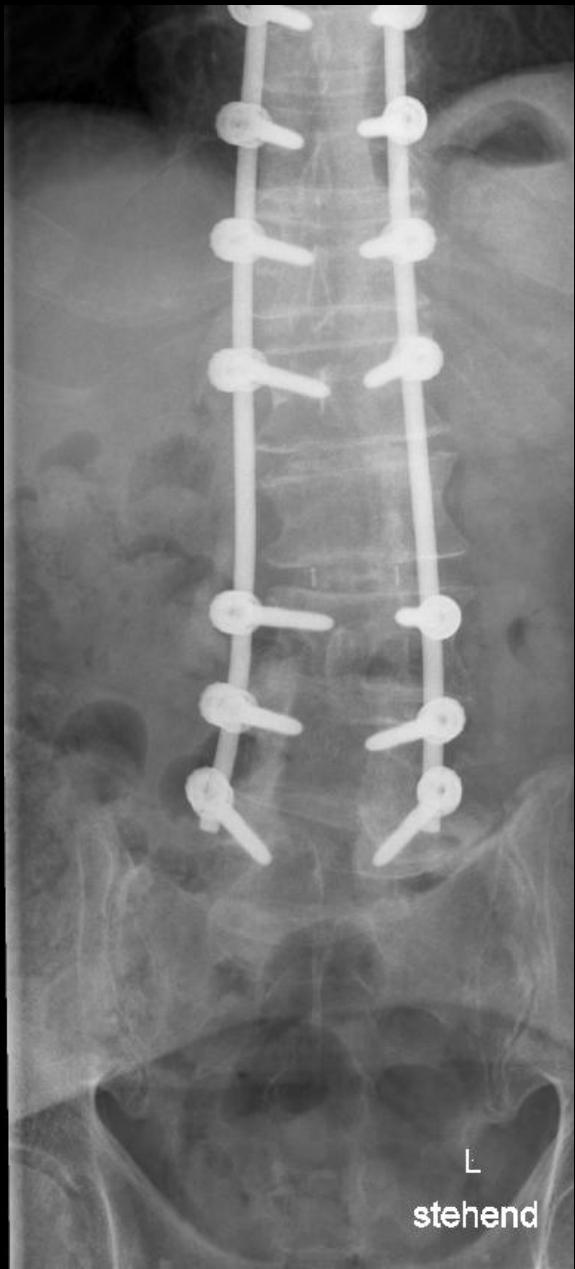








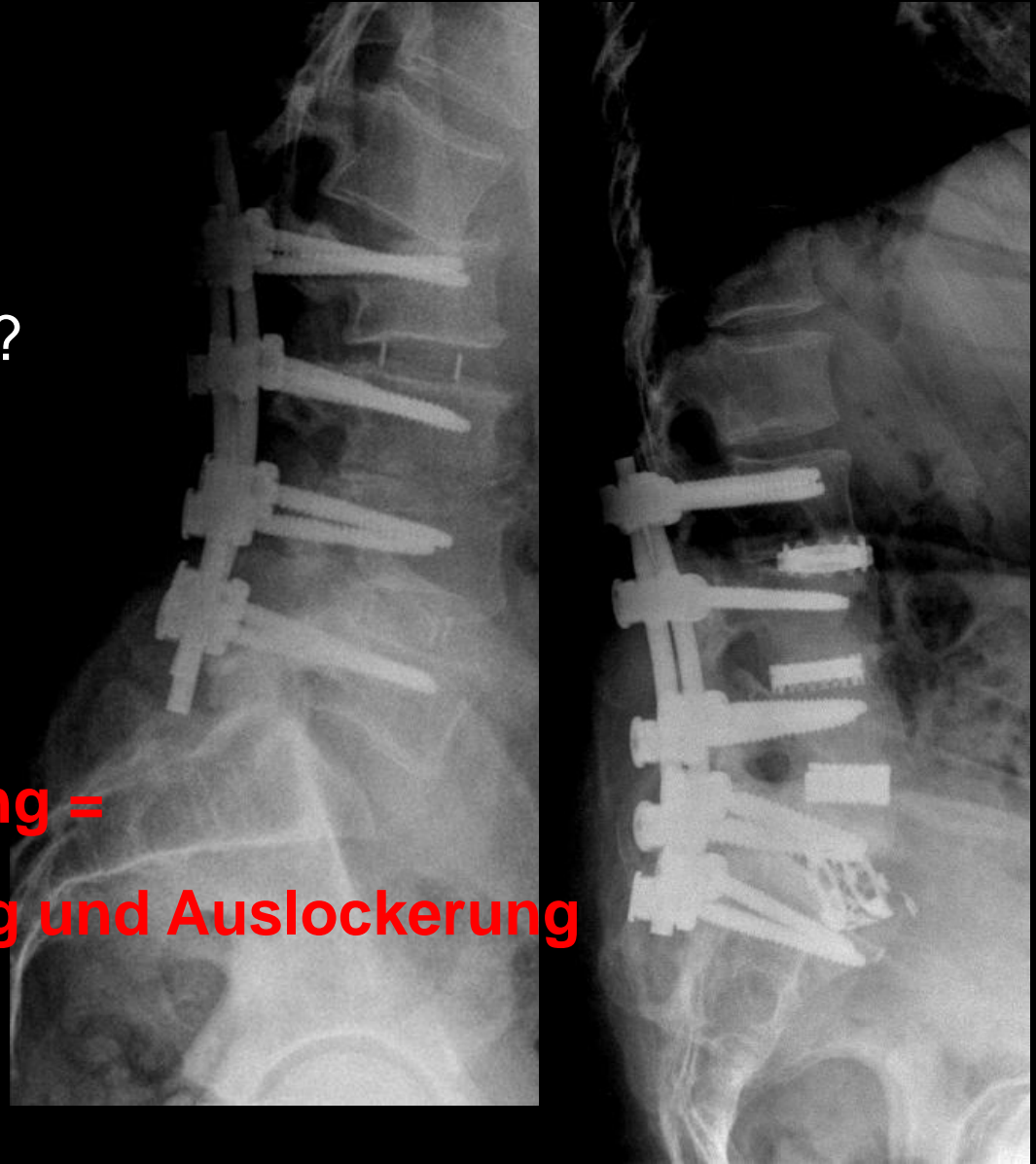




Ursachen ?

- Biomechanisch:
 - Verlängerte Hebel?
 - Ventraler support?

**Rezidivierende Belastung =
Materialermüdung und Auslockerung**

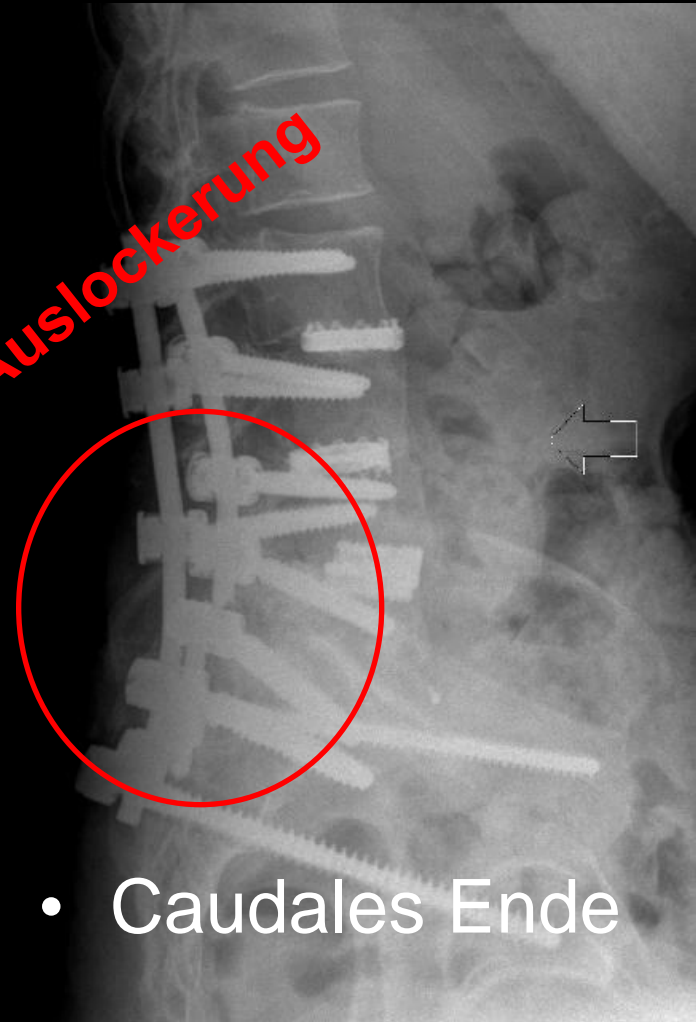


Prädilektionsstellen

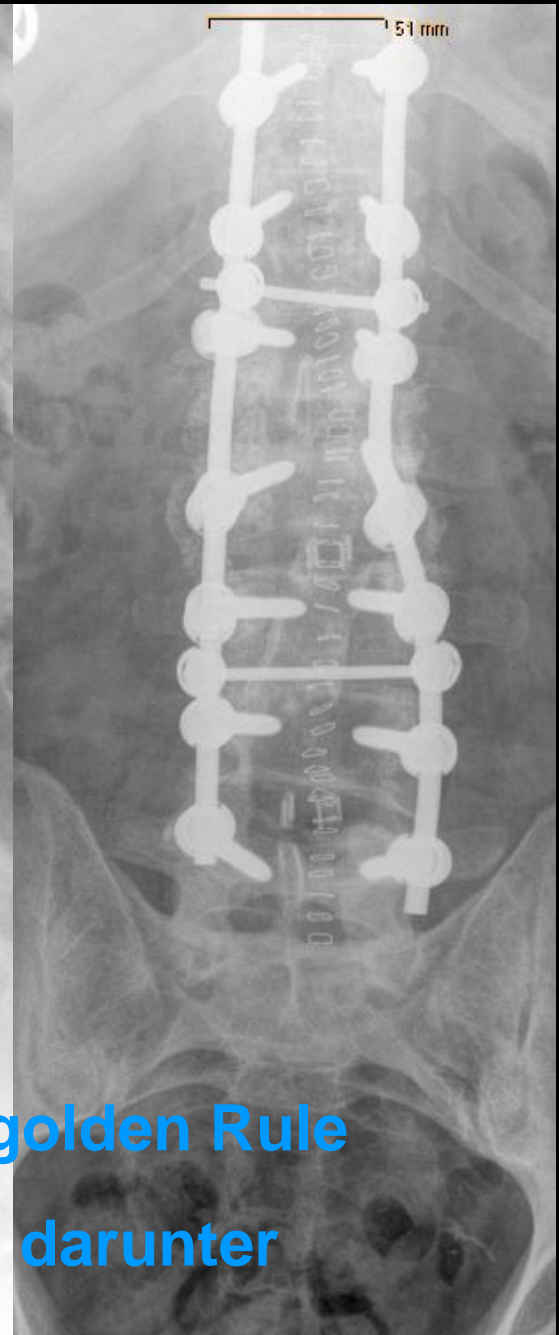


- Rostrales Ende

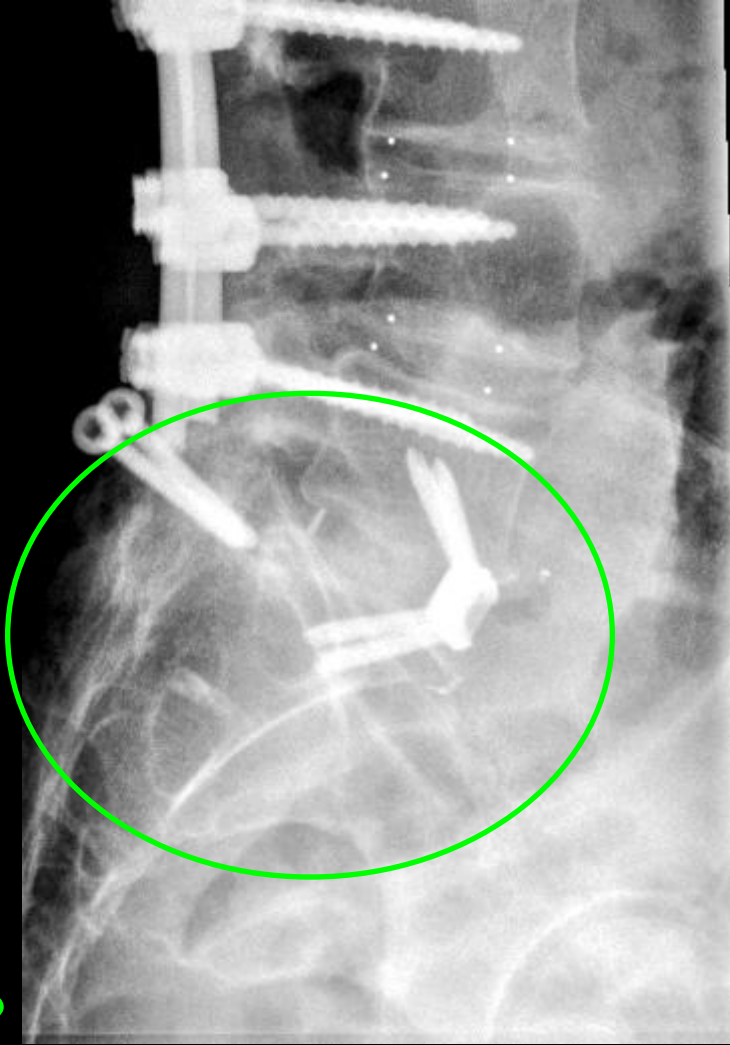
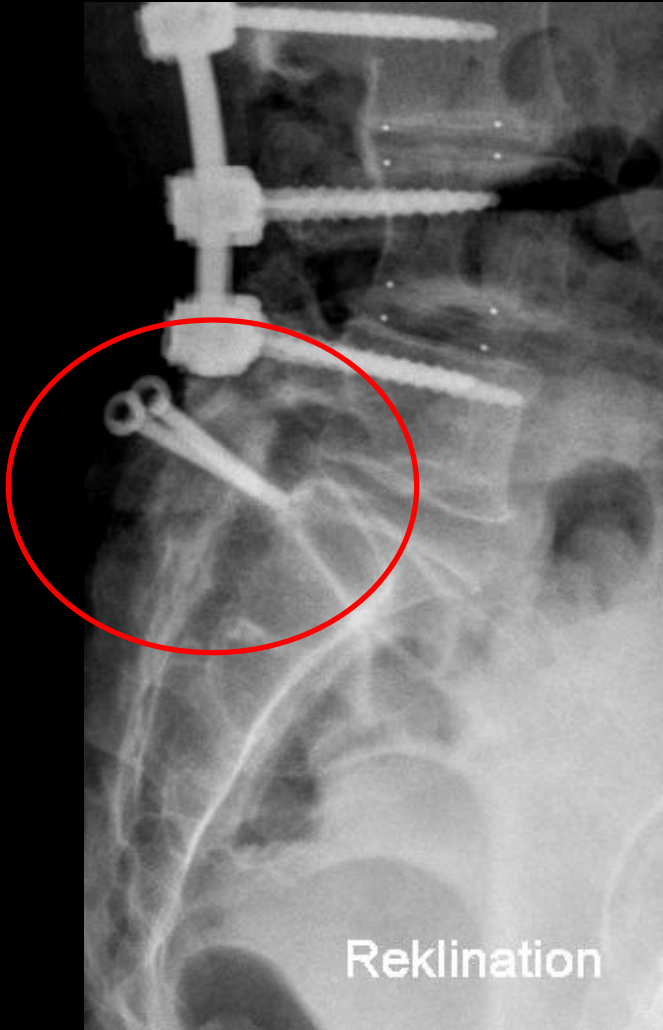
Rezidivierende Belastung =
Materialermüdung und Auslockerung



- Caudales Ende



Wenn dann golden Rule
2 darüber / 2 darunter



Anterior stand alone?

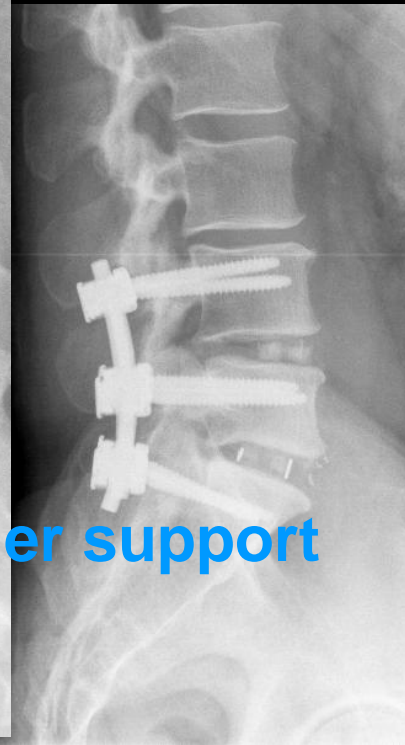
A good choice when ever its possible!

Therapie = Prophylaxe

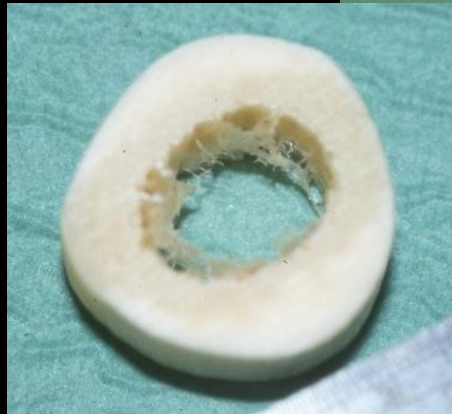
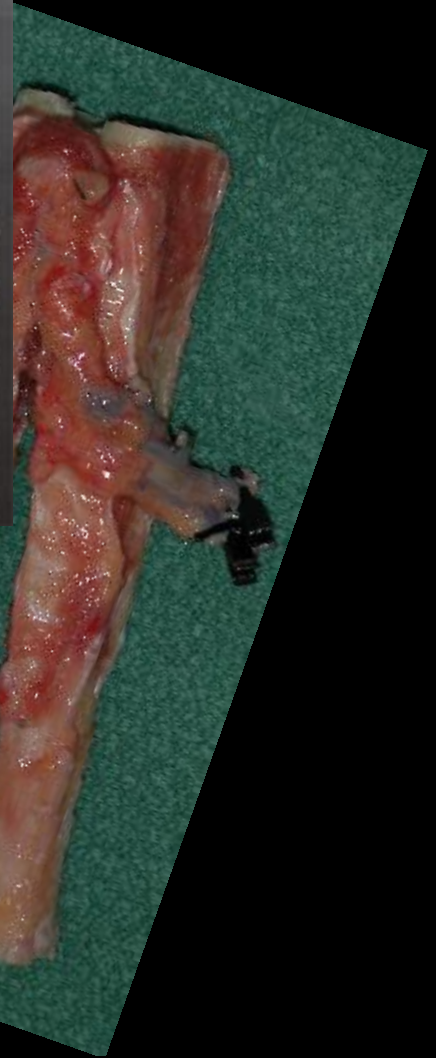
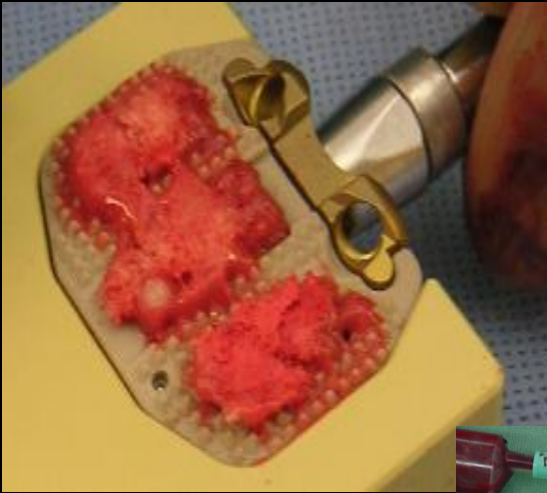
- Fusion
- Fusion
- Fusion



- Ventraler support



Fusion Ventraler Support Fusion



BMP-2 **BMP-7**

LITERATUR

Favorisiert dynamische Implantate und

Arthroplastie

Generell TDR und dynamisch Implantate abnehmend –
Gründe?

Keine Korrealation zw. Bildgebung und klinischen Verlauf

Veränderungen im Anschlußsegment auch ohne OP
nachweisbar !!!

Take home message

Wiederherstellung der Lordose

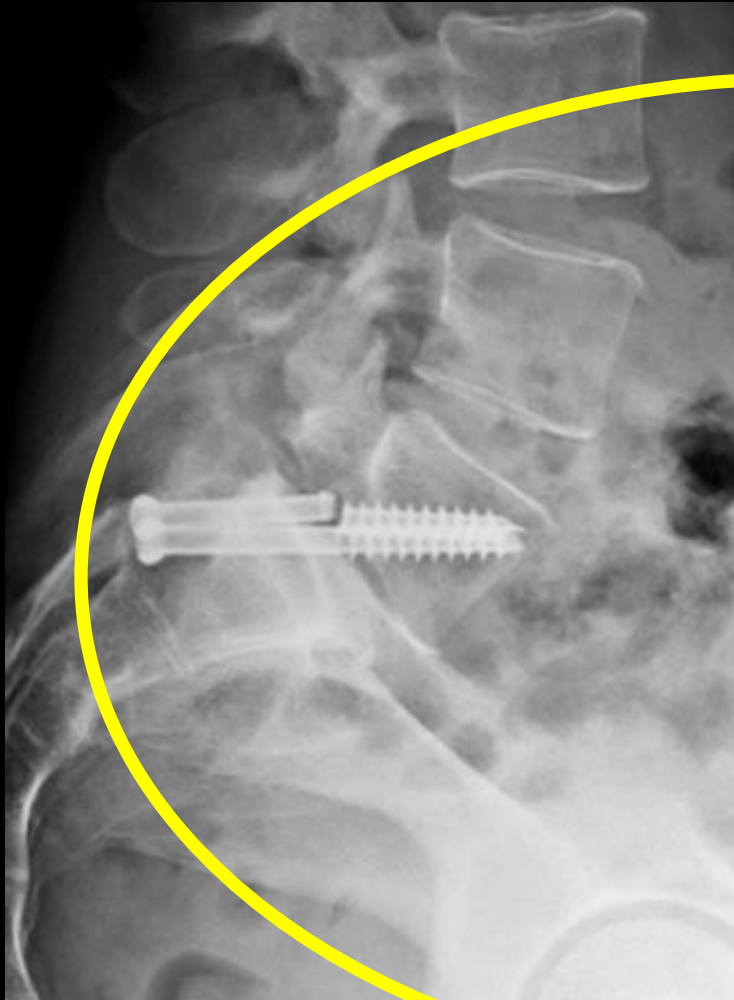
Restaurierung der sagittalen Imbalance

Ventrale Support

Fusion

So kurz als möglich

Beachtung des sagittalen Profils und thoracolumbalen
Übergang



Danke!!